CHAPTER 4

CONSTRUCTION AND OPERATION

4-1. Construction Sequence.

a. All trenches should be constructed as a series of cells sized by the designer in the most cost efficient manner. Cells should be divided by berms or other means, and storm water should be eliminated from the working portion of the landfill. The purpose of this approach is to minimize—

(1) The size of bottom and cap liners.

(2) The quantity of excavation required.

(3) The area of woodlands cleared. Efficient use of the landfill area should be maximized. The amount of initial excavation will be minimized because, while one cell is being filled with waste, the next cell in sequence is being partially excavated. When the current working portion is completed, the liner system should be extended over the newly excavated cells. Once the new cells become the active cells, the cap system will be extended over the completed cells.

b. All of the first cell and approximately half of the second cell will be excavated at the outset of the project. (See fig 4-1). The leachate collection system and landfill liner will be installed in the completed cell.

c. After the next cell is excavated and before the active cell is full, the composite liner and leachate collection systems will be extended over the new cell. The anchors will be excavated and the liners connected to form a continuous liner system. If berms are used, the berms will be left in place to separate leachate in each cell. Once the next cell becomes the active cell, all completed cells will be covered with the final cap and the gas venting system will be installed. The cap liner and gas venting system for each cell will connect to that of the adjacent cells to form a continuous system. The driveway into the landfill will be moved as needed to accommodate construction.

4-2. Construction Practices.

Important considerations in construction are:

a. Construction equipment must never operate directly on or above a landfill liner and/or drainage layer. All soil and layers on waste must be pushed ahead of equipment as operations progress. Even foot traffic should be kept to a minimum on membrane liners, and heavy boots should not be worn.

b. A good access road must be maintained in the trench with additional subbase installed between the roadbed and the drainage layer below.

c. Membrane liners are highly susceptible to expansion and contraction during temperature changes, and must be laid in such a way as to avoid undue stress on the seams.

d. Black liner material readily absorbs heat and can result in hazardous working conditions and bad seam construction. To avoid this, seaming should not be done during hot periods when the temperature exceeds 90 degrees F. Seaming is generally done during morning hours after dew has evaporated. Also, in most locations it is best to schedule work in the spring or fall.

e. Liners should be held in place by anchor trenches, sand bags, or soil cover. Anchor trenches are commonly used at the top of side slopes, but should not be compacted firmly. It is better for the liner to slip slightly than to cause stress. Methods of anchoring a liner should be coordinated with the liner manufacturer.

f. If it is anticipated that a liner will be excavated and extended to cover a new cell at a later date, a minimum 5-foot edge of liner material should be protected to provide a clean, smooth surface for future seaming. One method of doing this is to sandwich the end between two pieces of liner before it is buried under a berm or anchor material.

g. Require the contractor to write the name of the seam installer along the side of the seam. This will improve the quality of work.

h. Seaming of wet membrane surfaces will not be allowed.

4-3. Construction Quality Assurance.

a. All piping systems and compacted clay liner shall be inspected and tested in accordance with applicable standards. The construction contractor shall be required to submit field installation directions for the flexible membrane liner as supplied by the manufacturer, in addition to manufacturer quality control guidelines. The contractor shall follow the manufacturer's guidance during installation and inspection. All seams shall be visually inspected by Government personnel in addition to the contractor.

b. Nondestructive tests are available for various types of liner seams. One popular method of constructing a seam is to solvent weld two parallel seams together leaving an air space between them. This allows an air pressure test to be conducted

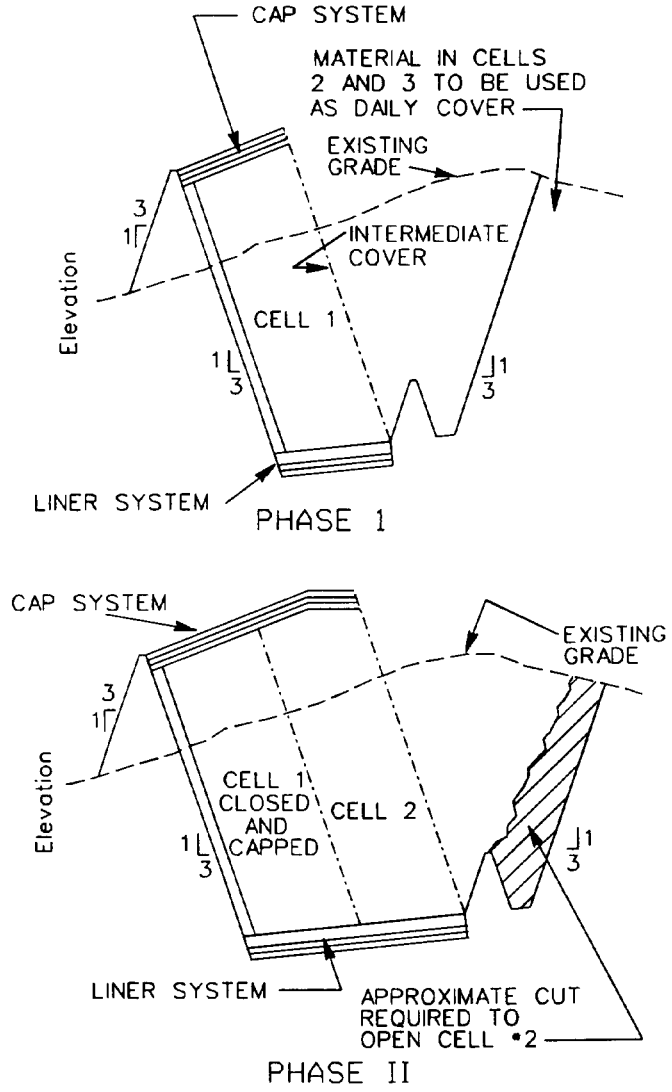

Figure 4–1. Construction Sequencing.

using an air pump to create pressure in the void. Any leak will be quickly indicated by a drop in pressure, and can be found by visual inspection and listening for leaks. Soap bubbles applied to the seam can also isolate a leak.

c. Destructive tests must also be performed by an independent testing laboratory. Directions for conducting tests must be provided by the manufacturer and must be followed. Generally, test strips are randomly cut from the liner seam at intervals of 300 to 500 feet. In addition, test strips will be taken at all corners and pipe penetrations. Shear tests will be performed on the strips in accordance with ASTM D 638. Some liner manufacturers also request a peel test in accordance with ASTM D 413, and will provide a laboratory either on or off site for this test. Many experienced liner installers will perform destructive tests in the field as part of their own quality control program. However, field tests shall not replace quality assurance testing by an independent laboratory.

4-4. Landfill Operations.

Proper site selection and design alone are not sufficient to produce a landfill which protects public health and the environment. In order to achieve these goals, the landfill should be operated using these guidelines.

a. Restrictions. A landfill facility for the disposal of solid waste should be operated in accordance with the following:

(1) In general, only wastes for which the facility has been specifically designed will be accepted for disposal. However, other wastes may be accepted if it has been demonstrated to the using agency that they can be satisfactorily disposed within the design capability of the landfill, or after appropriate modifications have been made.

(2) Specific wastes, whose chemical, biological or physical characteristics are not compatible with landfill design, location or methods of operation will not be accepted. Also, wastes which could pose unacceptable environmental or health risks, or threaten the safety of personnel using the facility will be prohibited.

(3) The Resource Conservation and Recovery Act of 1976 (RCRA) restricts the disposal of hazardous waste to landfills which are specifically designed for those wastes. Designers will specify which wastes may be handled at each facility, and operating personnel will be made aware of all restrictions.

(4) Landfill design should prohibit certain nonhazardous solid wastes, or as a minimum require pretreatment.

(5) Criteria for municipal solid waste landfills, as promulgated in 40 CFR 258, limits bulk or non-containerized liquid waste placed in a sanitary landfill to *(a)* household waste (other than septic waste), *(b)* leachate, and *(c)* gas condensate from the landfill itself.

(6) A container holding liquid wastes cannot be placed in a sanitary landfill, unless it is one gallon in size or smaller, it is designed to hold liquids for uses other than storage, or the waste held is a household waste.

b. Cover. Most soils can serve as cover material. Cover material should be applied as necessary to minimize fire hazards, odors, blowing litter, and vector growth; discourage scavenging by animals; control venting of landfill gases; infiltration of precipitation; and provide an aesthetic appearance. A minimum 6 inches of soil cover material must be applied at the end of each working day. Cells which will have no additional wastes placed on them for three months or more should be covered with 12 inches of material. Synthetic cover materials, such as geotextile products, can be used but generally are not cost effective and their use must be approved by the Director of an approved state program.

c. Working Face. To provide additional protection for the liner system, waste will be placed on the bottom and sides of the lined trench, and compacted until the liner is completely covered with at least four feet of waste and soil. Once this four-foot layer is in place, waste will be deposited in vertical cells on the end slope to form a working face which will exctend across the trench and advance toward the berm. Daily and intermittent cover should be obtained from the adjacent cell under construction (generally using a scraper). Wastes should always be placed at the toe of the working face. Asbestos materials must be encapsulated in plastic before being brought to the landfill, and then covered with soil or other wastes before compaction. Uncompacted waste will be spread in layers no more than 2½ feet thick before compacting. Once compacted, another layer can be added and then compacted so that the waste cell will be several feet thick before the soil cover is added. The working face should have a 20 to 30 percent slope, and be as narrow as feasible to accommodate the number of trucks using the landfill.

4-5. Equipment.

There are several basic types of equipment used at landfills, and each has one or more specific functions. Excavation can be accomplished by a track dozer, front-end loader, dragline, or scraper. For landfills where excavation and filling operations are taking place simultaneously, scrapers are most commonly used for excavation because of their versatility. Compared to other equipment, scrapers are good for excavation and excellent in hauling and spreading cover material, while eliminating the need for trucking of wastes. Front-end loaders are generally used for moving large rolls of synthetic liner material, and spreading the liner over the site. Dozers and compactors are best suited for preparing the landfill base and drainage layers. Track dozers are commonly used to spread refuse and cover material, break up hard deposits for scrapers, and push trees, stumps, and rocks during clearing operations. Loaders are good for spreading wastes also, but do not have the pushing power of dozers. In general, operators find the most useful piece of equipment to be a steel-wheeled compactor equipped with a landfill blade. It achieves excellent compaction and can be used for spreading refuse and cover material. Many moderate sized landfills are operated with a steel-wheeled compactor, track dozer, and scraper. All operating equipment coming in contact with solid waste must be designed specially for landfill use. Equipment must be provided with guards to prevent refuse from clogging moving parts, and to protect operator personnel. It will be necessary to consult with manufacturer representatives to select the best equipment.

4-6. Climate.

Adverse climate can severely limit the capability of a sanitary landfill, but this can be partially overcome by planning and modified operational procedures.

a. Cold Weather. Extremely cold weather can greatly reduce the biological activity in a sanitary landfill. It is reported that in areas where winter temperatures are less than - 30 degrees F, only minimal waste stabilization occurs. A serious problem in cold regions is frozen soil. This can be overcome to some extent by excavating for the fill during the summer season and stockpiling cover material.

b. Warm Weather. Extremely warm weather may affect workers but has no adverse impact on landfill operations. However, as discussed previously, hot weather will affect the installation of the liner. For most landfills, installation of a new liner and extension of existing liners over new cells should be scheduled during the spring and fall seasons. Seaming during hot mid-day periods should be avoided.

c. Wet Weather. The major problem during wet weather is maintaining maneuverability of vehicles and equipment used to handle the solid waste. This can be prevented in design by selecting a site that is well drained and has soil that provides for adequate vehicle handling when wet. Modifying operational practices can also reduce this problem. Surface drainage can usually be diverted away from open excavations by careful grading as mentioned earlier.

d. Dry Weather. Dry weather problems in a sanitary landfill are operational in nature, such as working under adverse conditions created by blowing dust, paper and debris. A certain amount of moisture is needed for biological activity to take place in the landfill. However, it is unusual to have to add water for this purpose. Control of blowing refuse can be accomplished by promptly covering waste materials, and by erecting portable fences downwind of the open trench.

4-7. Operating Records and Controls.

a. Reasons for Recordkeeping. Records are maintained to determine historical operating costs, which can be used to project future needs. Good records are invaluable in developing general landfill design procedures in that capacity requirements and operating parameters can be analyzed and compared with other systems. Designers must also determine how data will be collected and provide the necessary equipment for doing so.

b. Waste and Source Data. The most important information in managing a solid waste system landfill facility is the quantity, type, and source of waste being collected for disposal. Truck scales are employed to determine the quantity of waste from each source. The type of wastes can be determined from recycling programs. To assist in recycling, waste from each truck visually classified into the following categories:

(1) Paper.
(2) Cardboard.
(3) Lumber.
(4) Textile products.
(5) Aluminum.
(6) Ferrous metals.
(7) Glass.
(8) Sand and gravel.
(9) Plastic.
(10) Food wastes.
(11) Concrete.
(12) Other wastes.

c. Computerized Systems.

(1) A simple, cost effective automated system for recording waste quantities consists of a personal computer (PC) and truck scales equipped with digital read-out. Due to the current emphasis on computerized systems, most digital truck scales can be connected to computers using readily available hardware. Manufacturers of truck scales and computer vendors can provide the necessary hardware and software packages.

(2) Computer programs for landfill management are available commercially from truck scale manufacturers and independent software companies. Such commercial programs must be modified to accommodate the needs of each specific user. The advantage of using commercially available programs is that they have been developed by experienced programmers who have a good understanding of landfill operation. Unfortunately, these companies may not be located conveniently to many users, thus causing delays in making adjustments and corrections. The ideal situation is to have local programs developed, thus allowing quicker response times.

d. Trench Data. To provide data for projecting the life of a landfill, trenches should be surveyed and a reference point at one end of each trench. Periodically, the distance from the reference point to the toe and top of the working slopes should be recorded. From these measurements, in-place volumes of landfilled wastes can be calculated. If operation of the landfill is consistent, it can be a monthly procedure with minimum impact on other operations.

e. Operational Data. To determine landfill operational requirements and associated costs, the following information is needed:

(1) Hours of landfill operation.
(2) Hours of equipment operation.
(3) Fuel consumption.
(4) Major repairs.
(5) Hours of down time for major repairs.
(6) Labor hours spent on major repairs.
(7) Routine maintenance.
(8) Labor hours spent on routine maintenance.
(9) Cover material used.
(10) Daily weather conditions.

The operational and trench data should be maintained in a computerized form, and also recorded manually in a log book.

4-8. Monitoring.

a. General. Monitoring is an essential activity in establishing, operating, and closing a solid waste landfill disposal facility. Where possible, monitoring should be coordinated with State and local air and water quality management activities. Landfill disposal facilities should be monitored as follows for the purposes of determining if and when a contingency remedial action plan should be implemented to correct an environmental problem.

b. Ground-water. A ground-water monitoring system will be installed at all landfill disposal facilities which have the potential for generating substantial quantities of leachate. In no case shall ground-water monitoring wells be installed through the bottom of the landfill proper since such installation could create a conduit for the direct passage of leachate into underlying groundwater. Prior to disposing of solid waste at a new landfill facility, samples from monitoring wells will be collected and analyzed in order to obtain baseline data on existing ground-water conditions. Samples should be collected from all monitoring wells and analyzed at least once a year. The analytical methods specified in 40 CFR 136 will be followed.

c. Facility and Structures. All enclosed structures at a landfill disposal facility should be monitored regularly to detect accumulations of explosive gases such as methane. Detection of other gases which might pose a safety hazard to employees and workers should also be considered. Explosive gases, can be detected with a device called an "explosimeter." Toxic or asphyxiating gases should be monitored on a regular basis with appropriate instruments.

d. Perimeter Soil Monitoring. In most cases where landfills are lined and the material used for daily cover is relatively porous, gases generated within the landfill will not move laterally away from the site, and thus perimeter soil monitoring is not necessary. However, if such soil gas monitoring is required, the following shall be observed:

(1) Suitable probes should be installed in the soil at the property boundary surrounding the landfill to enable detection of gases migrating away from the facility.

(2) Explosive gases should be monitored for concentrations above the lower explosive limit.

(3) Toxic or asphyxiating gases should be monitored on a regular basis with appropriate instruments.